# Sfb 1946

## **A1**

# Coupled Simulation of Heterogeneous Hydrological Systems: Numerical Modeling of Runoff Generation in Lowland Areas

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### **Motivation**

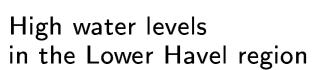
Lowland areas with high water tables are typical landscapes in NE-Germany.

They are **both** important for agriculture **and** ecologically high valued.

The quantification of water resources and the dominating hydrological processes in lowlands is required:

- for a sustainable agricultural use of these landscapes,
- for the preservation of their ecological value and
- for the environmental impact-analysis of management measures.







Protected birds habitat in the Lower Havel region

Hydrological systems of such environments are very complex:

- Various interactions of hydrological processes and compartments, e.g. unsaturated soil zone, ground water, and surface water
- Very strong space—time variations of the governing processes
- Understanding of these coupled systems by the use of mathematical models of the governing hydrological processes and their interactions

#### Goal

The overall goal of this project is to improve the understanding of the complex hydrological lowland system by means of refined numerical modeling methods.

## **Hydrological Modeling**

Most state—of—the—art hydrological models reflect the fluxes between surface and sub—surface compartments in an *uncoupled mode*, i.e. without feedback mechanisms.

Therefore, they are hardly suitable for the simulation of runoff generation in *lowland areas*, where the interaction of unsaturated soil, ground water and surface water might dominate other hydrological processes.

## **Cooperations**

WITHIN SFB:

A2, B2, C2 (adaptive multigrid), A3, C1 (domain decomposition techniques), B1, B3 (numerical analysis), C4 (ode solvers) BEYOND SFB:

P. Bastian (Heidelberg), R.H.W. Hoppe (Augsburg), V. Krysanova (Potsdam), B. Merz (Potsdam), R. Nochetto (Maryland), J. Schönfelder (Potsdam), P. Troch (Wageningen), G. Wittum (Heidelberg)

### Research Strategy

Identification and monitoring of a selected lowland catchment

- measurements of spatial data
- time series of processes

Satellite image of our research catchment:



- surface—water observation station
- ground-water observation station
- soil-moisture observation station
- meteorological observation station
- □ research catchment

### Simulation based on a decoupled model

Extension of an existing hydrological model:

- feedback ground water to the surface water
- feedback ground water to the unsaturated zone and vegetation
- surface inundation processes

#### Robust and efficient solvers for a coupled model

- adaptive time stepping and mesh refinement
- robust multigrid solvers by combination of monotone multigrid and Newton multigrid

### Comparison of decoupled/coupled models

- Quantitative effects of coupling/decoupling versus data availability and computing time. Comparison with experimental data.
- Fast solvers allow for systematic quantitative studies: Influence of small scale data variability on relevant output data (water table).

## **Future Perspectives**

- nonlinear vegetational effects, evaporation and rainfall infiltration
- dynamics of surface water
- upscaling to larger catchments

## Relations to other projects

**Bänsch:** DFG-Research Center, Project C1 "Coupled systems of reaction-diffusion equations and application to the numerical simulation of direct methanol fuel cell problems."

DFG-Research Center, Project C2 "Efficient simulation of flows in semiconductor melts."

**Bronstert:** BMBF-Project "Options for Water Resources management in the Havel River Catchment."